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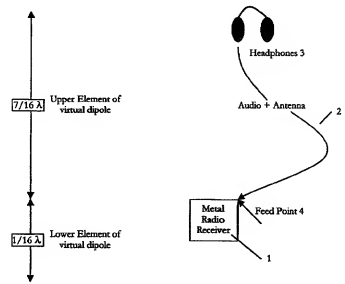
(56) Documents Cited
GB 2080647 A
EP 0706231 A1
WO 2001/065633 A2
US 5361405 A
EP 0977366 A1
EP 0308935 A1
FR 002390049 A

(58) Field of Search
UK CL (Edition V) H1Q
INT CL[7] H01Q, H04B
Other: Online: EPODOC, WPI, JAPIO

(54) Abstract Title
Portable radio device with antenna contained in headphone lead

(57) An antenna for a portable radio device, comprising a first element in the form of a flexible wire conductor 2 and a second element in the form of an electrically conductive casing 1 or electromagnetic shielding of the radio device. The two elements together form an asymmetric dipole antenna with the sum of the effective lengths of the elements being approximately equal to a half wavelength, but the effective lengths of each individual element being different. Alternatively, the casing element may operate as a ground plane with the flexible wire conductor operating as a monopole. In preferred embodiments, the wire conductor is part of the lead to headphones 3 and/or a microphone.

Figure 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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Figure 1

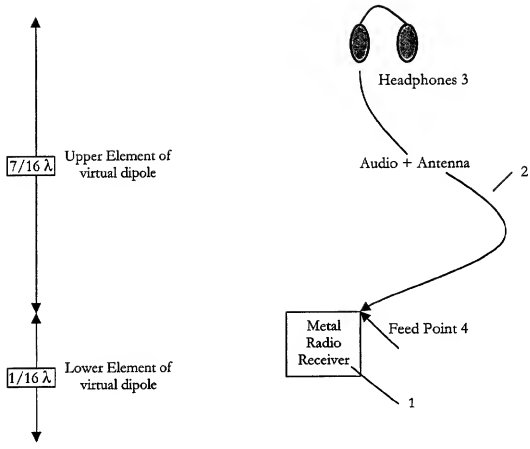

7/16 λ
Upper Element of virtual dipole
1/16 λ
Lower Element of virtual dipole
Headphones 3
Audio + Antenna
2
Metal Radio Receiver
Feed Point 4
1

Figure 2

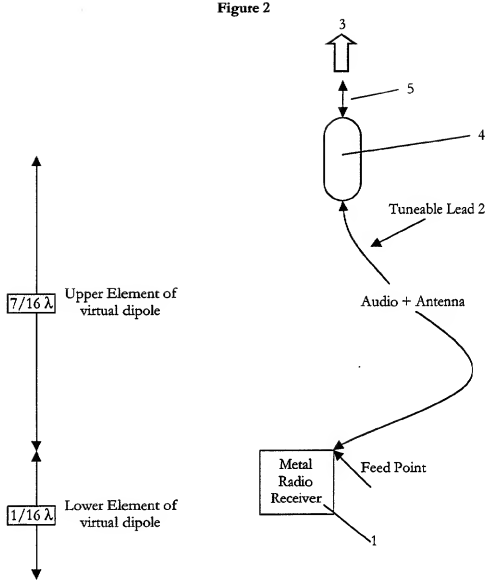
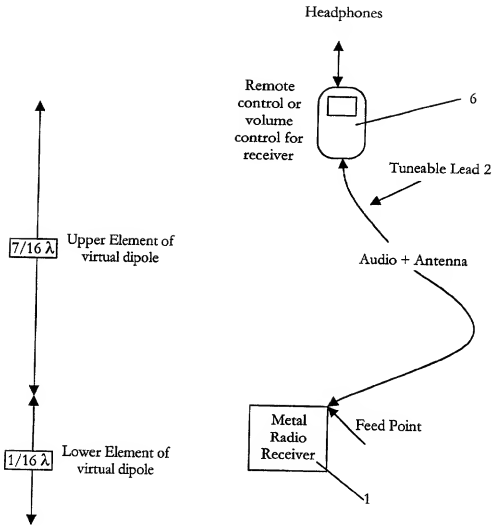

3
5
4
Tuneable Lead 2
Audio + Antenna
7/16 λ
Upper Element of virtual dipole
1/16 λ
Lower Element of virtual dipole
Metal Radio Receiver
Feed Point
1

Figure 3


Headphones
Remote control or volume control for receiver
6
Tuneable Lead 2
Audio + Antenna
7/16 λ
Upper Element of virtual dipole
1/16 λ
Lower Element of virtual dipole
Metal Radio Receiver
Feed Point
1

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ANTENNA FOR A PORTABLE RADIO DEVICE

FIELD OF THE INVENTION

This invention relates to an antenna for a portable radio device, such as a portable radio receiver.

DESCRIPTION OF THE PRIOR ART

Portable radio receivers are becoming smaller. The compact size of such devices creates significant problems for the integration of effective antennas, especially when the device operates at longer wavelengths – for which an antenna must be correspondingly long for the best possible reception (a shorter antenna will have reduced efficiency). Various solutions to this problem exist, which are to a greater or lesser degree unsatisfactory or have poorer performance than the invention described below. In particular, rigid telescopic antennas are awkward in use and prone to breakage; semi-rigid antennas formed from super-elastic alloy (NiTi or nitinol) are awkward in use and cannot easily be folded for stowage. .

The small size of portable radio receivers also makes it difficult to incorporate good-quality loudspeakers; the user may therefore choose to operate the device with headphones or earphones. It is known to provide a dipole antenna which utilizes the left and right wires of a pair of headphones to create a pair of approximately quarter wavelength symmetric arms of a dipole. This prior art antenna design, in common with typical dipole antennas, is symmetric, both electrically and as to form. (A typical dipole wire antenna comprises two wires of equal length meeting at a junction, while a typical

telescopic dipole would encompass so called 'rabbit ear' antennas – with two more or less identical telescopic components, etc). As noted above, the known dipole antenna which utilizes the left and right wires of a pair of headphones adopts a symmetric approach. But this leads to certain drawbacks. First, it requires a pair of headphones (i.e. with two speakers) to be used which may not be desirable if the user is not listening to a stereo sound signal. Second, in the event that the antenna is to transmit, it emits radio energy close to the brain, this recently has been the subject of some epidemiological concern. Third, it requires the user to employ a specific set of headphones which may not match that user's comfort or sound isolation requirements. Fourth, if the radio is carried at or close to the waistline, the signal quality may be degraded over the length of connecting cable between the dipole centre and the radio. Fifth, if the dipole antenna is incorporated in the headphone leads, the requirement that its length corresponds to the transmission and reception band of the radio may result in awkwardly long or short leads.

SUMMARY OF THE INVENTION

In a first aspect of the invention, there is an antenna for a portable radio device, in which a first element comprises a flexible wire conductor and a second element comprises an electrically conductive casing or electromagnetic shield of the device.

The elements can be thought of as a dipole; this dipole is typically asymmetric, with the sum of the effective lengths of the elements (or poles) being approximately a half wavelength but the effective lengths of each element being different. Conversely, the dipole may be roughly symmetric with the sum of the effective lengths of the elements being approximately a half wavelength. Equally, the skilled implementer will appreciate that the electrically conductive casing or electromagnetic shield of the device may in fact operate as a ground plane, with the flexible wire conductor operating as a monopole.

The term 'flexible' requires that the flexible wire conductor can be easily bent, twisted or otherwise deformed and does not then regain its former shape, unlike whip or semi-rigid antennas. This is important since the flexible wire conductor typically has to hang down unobtrusively and comfortably.

The flexible wire conductor itself may typically be a 'tuned' lead; it is tuned by being manufactured to a pre-defined length in order to match the incoming signal and the received input. It will typically form part of a lead to a headphone for the device and/or a microphone for the device- i.e. the leads are dual purpose, being both part of the antenna and also carrying data, such as analogue signals driving headphones. More

generally, the wires that accompany the antenna wire may be for any kind of data connection and may be electric or optical.

In a preferred implementation, standard cable shielding (inside which the audio cables lie) is the flexible wire conductor. This gives maximum exposure to that element.

It is also possible to have antenna leads which are separate from the headphone leads, and are in separate channels of the same insulating sheath (or even in separate insulating sheaths).

The tuned lead can be terminated in a connector, to which the user may attach headphones and where appropriate a microphone of the user's choice. This connector may contain controls and/or a display for the radio transmitter receiver, including but not necessarily limited to volume controls.

Multiple antenna wires of varying lengths corresponding to different operating bands for the radio device may be embedded in a flexible plastic casing forming the flexible wire conductor and may, via a connector, be switchably connected to the conductive casing or shields of the device, allowing the combination to form various poles of different lengths.

The antenna may be used for any portable radio receiver and/or transmitter device which requires an antenna length of a half multiple of the wavelength transmitted or received, including but not limited to RF wavelengths between 3 cm and 3 meters for transmission

and/or reception via FM, Band III, L Band and Eureka 147, any type of broadcast, analogue or digital, including audio, video, compressed audio and compressed video, data, weather news, travel information, share price information and other similar broadcast text or media services either unconditionally or via a conditional access service.

In a second aspect, there is a portable radio device comprising an antenna as defined in the first aspect of the invention.

SUMMARY OF THE DRAWINGS

Figure 1 is a drawing of an antenna in accordance with the present invention in which 1/16 of the dipole antenna is provided by the receiver metal housing and 7/16 is provided by a headphone lead. The overall length of the dipole is a half wavelength. In the case of Figure 1 the headphone lead would have to be manufactured to a specific length so as to tune it to the radio band the user wishes to receive.

Figure 2 is a variation of the Figure 1 antenna in which the tuned headphone lead, terminates in a headphone 'jack'. In this case any headphones (including mono or stereo headphones) may be used and plugged into this jack. The tuned lead length will be selected to provide maximum gain in the appropriate band for the receiver and maximum match for the receiver input.

Figure 3 is a variation of the Figure 2 antenna showing the addition of a remote control unit between the tuned lead and the headphone jack. This remote control unit may either form part of the tuned lead or be connected via an appropriate connector.

DETAILED DESCRIPTION

The invention is described by reference to a digital audio broadcasting (DAB) radio receiver now under development by PSION Digital Limited of the United Kingdom. However, it should be noted that the invention may be applied to a wide range of radio receivers including receivers operating in the FM radio band and to compact radio transmitters.

The first version of the invention is illustrated in **Figure 1**. There, the metal cased radio **1** and the headphone antenna **2** are arranged in such a way as to comprise an asymmetric electric dipole antenna. The lower dipole element of the antenna is formed by the radio receiver metal case **1** or internal shields and the upper dipole element is provided by the cable shielding in the tuned lead **2** which connects in turn to the headphones **3**. The design requires that these components be tuned is such a way as to simulate a dipole ($1/16^{th}$ of a wavelength for lower dipole element 1; $7/16^{th}$ of a wavelength for the upper dipole element) – the precise, optimum length can be established experimentally.

A key and unique feature of this configuration is that the feed point **4** from the dipole is extremely close to the radio receiver RF input, thus ensuring good efficiency for the antenna. This variation of the invention may require appropriate tuning components to maximise performance with one particular design of headphones.

In a second variation of the invention as shown in **Figure 2**, a tuned lead **2**, incorporating a flexible wire element of an antenna dipole (the cable shielding, as in **Figure 1**) and audio leads to drive headphones **3**, is introduced between the receiver **1** and the headphones **3**. The tuned lead **2** terminates in a connector jack **4** into which a headphone plug can be inserted. The second element of the dipole antenna is again formed by the radio receiver metal case **1** or internal electromagnetic shields. In this case the complete headphone **3** and headphone lead **5** do not constitute part of the antenna and therefore the radio characteristics of the headphones **3** and length of the headphone lead **5** has no effect on the efficiency of the antenna. Rather the radio characteristics of

the antenna are dictated by the tuned lead **2** which extends up to the connector jack **4**. Differently optimised tuned leads can be introduced to cover different bands or offset bands to cater for the differing standards of radio transmissions from one region to another. This design allows the user to use their preferred headphones with the device without adversely affecting the reception performance of the antenna.

Figure 3 shows another variant in which the tuned lead **2** terminates in a wearable remote control **6** which provides a means of connection and a means of remotely controlling the radio receiver **1** in the one package. The remote control **6** may be connected to the tuned lead **2** by means of a connector but forms part of the upper dipole element.

It should be noted that, at each end of the tune lead **2**, there are additional components (i.e. inductors) intended to isolate the audio leads (signal and ground) from the RF signals. These would typically be included within the product casing **1** and the remote control **6**.

CLAIMS

1. An antenna for a portable radio device, in which a first element comprises a flexible wire conductor and a second element comprises an electrically conductive casing or electromagnetic shield of the device.

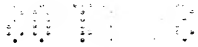
2. The antenna of claim 1 in which the flexible wire conductor is a tuned element which forms part of a lead to headphones for the device and/or a microphone for the device.

3. The antenna of Claim 2 in which the flexible wire conductor terminates in a connector into which a user may plug headphones and/or a microphone.

4. The device of Claim 3 in which the connector comprises controls and/or a display for the device.

5. The antenna of Claim 2 in which multiple antenna wires of varying lengths corresponding to discrete operating bands for the device, are embedded in a flexible plastic casing to form the flexible wire conductor and can, via a connector, be switchably connected to the conductive casing or shields of the device, allowing the different combinations to form various dipoles of different lengths.

6. The antenna of Claim 2 in which a RF input for the device is located at or in close proximity to a feed point.



7. The antenna of Claim 1 in which the flexible wire conductor comprises cable shielding.

8. The antenna of Claim 1 which is asymmetric, with the sum of the effective lengths of the elements being approximately a half wavelength but the effective lengths of each element being different.

9. The antenna of Claim 1 being a dipole antenna, with the first element one pole and the electrically conductive casing or electromagnetic shield of the device the other pole.

10. The antenna of Claim 1 in which the electrically conductive casing or electromagnetic shield of the device operates as a ground plane, with the flexible wire conductor operating as a monopole.

11. A portable radio device comprising an antenna as claimed in any preceding claim.

Application No:	GB 0226894.4	**Examiner:**	Dr Mark Shawcross
Claims searched:	1-11	**Date of search:**	31 March 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1 & 8-11	EP 0308935 A1	(ALCATEL); abstract, col.3 lines 27-30 & lines 52-54 & figures 1 & 2
Y	1, 2, 7 & 8	EP 0706231 A1	(MITSUBISHI); col.2 line 37 to col.3 line 2, col.5 lines 24-38, col. 10 lines 6-47 & fig. 11
Y	1, 2, 7 & 8	GB 2080647 A	(SONY); abstract, p1 lines 87-94 & p3 lines 6-47
A		EP 0977366 A1	(TAIGULF); col.1 lines 22-47
A		US 5361405 A	(RAMSEY); abstract, col.1 lines 58-61 & figure 1
A		FR 2390049 A	(PHELIZON); abstract and figure
A		WO 01/65633 A2	(KIRINO); abstract & p2 lines 16-17

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

H1Q

Worldwide search of patent documents classified in the following areas of the IPC[7]:

H01Q, H04B

The following online and other databases have been used in the preparation of this search report :

Online: EPODOC, WPI, JAPIO